RURAL DENTAL CLINICS IMPACT ON TRAVEL DISTANCES FOR MEDICAID CHILDREN

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ABSTRACT

Children living in rural environments and dependent on the Medicaid or CHIP public insurance coverage systems have limited accessibility to private dental offices. This study examines the impact of public policy changes on travel distances for families and uses Missouri Medicaid/CHIP administrative claims data from 2004 to 2007 for rural children 18 years and younger (N=193,165). Distances travelled to dental providers were calculated for rural families. Families were travelling on average 28 miles to obtain appropriate care for their children, and only slightly less in the posttest period. However, the expansion of public health clinic services and the development of new clinic locations may be lowering the overall travel distances for rural families. Clinics were found to have "hub" properties, improving the geographic availability of care to rural children that may have otherwise had to travel long distances. Policymakers should take an intentional strategy of service hubs in public policy.

INTRODUCTION AND PURPOSE

Good oral health is important to children's overall health and well-being. Children living in rural environments and dependent on the Medicaid or Children's Health Insurance Program (CHIP) public insurance coverage systems have limited accessibility to private dental offices. Rural populations in general have lower dental care utilization than other geographic populations (Douglass and Cole 1979; Skillman, et al. 2010). The National Conference for State Legislatures identified two primary factors limiting oral health access for the rural population: geographic isolation and shortage of dentists (Gordon 2007). Accessibility is a dominant barrier to utilization of health care for rural underserved populations and is geographic in nature (Ricketts et al. 1994). Access to care and utilization of services are adversely affected by longer travel distances (Chan, Hart, and Goodman, 2006). Due to geographic barriers, rural families may have to travel long distances to utilize the services of private dentists. Proximity to a particular provider has been found to be a predominant reason individuals use that resource (Meade and Earickson 2000). Most dentists cluster in urban and suburban areas, leaving shortages in many rural communities. Dentists are significantly underrepresented in rural counties, especially in smaller and more isolated regions (Andrilla Lishner and Hart 2006; Brown 2005).

The overall participation of the private dental workforce in Medicaid and CHIP is low, resulting in low availability of Medicaid/CHIP dentists, especially in rural regions. Using the 2001 National Household Travel Survey, the South Carolina Rural Health Research Center found the average distance traveled for medical or dental care was 10.2 miles, and the average time spent on the trip was 27.2 minutes (South Carolina Rural Health Research Center 2007). In an Indiana lawsuit over Medicaid reimbursement rates, the complaint stated parents had to drive 45 minutes to a pediatric dental office because none could be found in the county of residence

(Jefferson 1998). Families may not have a car, or must depend on unreliable transportation services; transportation costs drain already limited family resources; and support for transportation often comes from other family members (Kelly et al. 2005; Mofidi Rozier and King 2002; Vargas and Ronzio 2002). Therefore, while a multitude of factors underlie difficulty accessing care in certain locations, the interplay of those factors within certain geographic regions has been shown to impact care utilization. The overall shortage of dental professionals only exacerbates these problems, often resulting in families having to drive long distances to access care.

In response to the barriers confronted by Medicaid/CHIP populations accessing dental care, state governments are developing innovative, alternative policies and programs as solutions to the crisis (Hathaway 2009). Missouri, like all states, is dealing with obstacles in the delivery of oral health care. The state has engaged in various policy efforts to improve dental care utilization – workforce supply expansions, Medicaid/CHIP reimbursement increases, establishment of Medicaid managed care delivery systems, administrative changes, and support for oral health coalitions and community efforts. Thus, Missouri's story may provide insights into utilization of oral health care by rural children on Medicaid/CHIP through a descriptive case analysis.

Missouri initiated three particular sets of policies to address the barriers. These include allowing community-based health centers to run dental practices (2004), allowing dental hygienists to practice unsupervised in public health settings (2003, appropriation in 2005), and both state and philanthropic investments in dental clinics (2005, 2006).

The first policy mechanism that allowed greater participation in the Medicaid market was when the Missouri Dental Association (MDA) and the Missouri Primary Care Association

(MPCA) developed a program where Federally Qualified Health Centers (FQHCs) may contract with private practitioners to treat patients in their private offices and receive reimbursement for services through the Missouri Medicaid/CHIP program. This means the clinic may submit a claim to the Medicaid division under its business name (as opposed to the dentist performing the services). FQHCs could also continue to employ dentists and hygienists directly. However, statutory law still prohibited clinics from owning a dental practice, a common albeit little known regulatory mechanism to prevent the corporate practice of dentistry (Gehshan & Snyder, 2009). According to Daneman (2009), the MDA's rural members began to worry about the economic impact of expanding dental services at community health centers. Thus, the MDA pushed for legislation in 2002 that would regulate the practice of dentistry in nonprofit health centers at both the state and federal levels, causing a "rift" between the MDA and MPCA. However, the Missouri General Assembly chose to pass legislation in 2004[1] that acted as a deregulatory measure. It allows certain public health institutions to run a dental practice. FQHCs must file a registration form with the Missouri Dental Board every other year; it is not a "permit" that can be revoked – it is an acknowledgement that the FQHC owns the dental practice (personal communication, Oral Health Network of Missouri, June 17, 2010).

A second deregulatory public policy measure taken in Missouri was legislation to increase the workforce supply by expanding the capability of dental hygienists to work in community and public health settings. In 2001, deregulatory legislation passed to allow dental hygienists to practice in public health settings without supervision of a dentist.[2] Changing restrictions in the dental practice act can increase capacity and access to care (Vargas & Arevalo, 2009).

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[1] Senate Bill 1122 (2004) was enacted into law and is codified in Chapter 332 of the Revised Statutes of Missouri.
[2] SB 393 2003; RSMo §332.311. Sunset date extended indefinitely by SB 828 in 2006.

Third, in recognition of the barriers limiting accessibility to an adequate supply of service points, both Missouri state government and philanthropic organizations made investments in community-based care. State-level public investments and philanthropic community initiatives to increase access have been contributing factors in utilization of oral health care. The primary contribution of these factors lies in making resources available to allow for greater expansion of access points for children seeking oral health care.

The Missouri Oral Health Preventive Services Program (PSP) became operational in September 2005. PSP is a community-based, systems approach to population-based prevention of oral health disease within the MO-DHSS, Office of Primary Care and Oral Health. It provides oral health education, materials (including toothbrushes), and fluoride varnishes. The program served 4,377 children its first year. The PSP program grew to serve 35,270 children from 91 counties across the state in 2009, drawing on the voluntary efforts of 236 dentists, 383 dental hygienists and 1,561 community volunteers (Branson, 2009). In 2006, the Missouri Foundation for Health provided $5 million to many community-based dental sealant programs, while the Health Care Foundation of Greater Kansas City committed $1.5 million to support 12 oral health projects in 2008. The philanthropic investments were primarily in rural fee-for-service, non-managed care counties.

Have these initiatives to improve the dental workforce supply and expand clinic locations to rural Missouri affected the travel distances to services in the oral health delivery system? This study examines the impact of changes to increase the workforce supply in the delivery network on travel distances to care for families. It expands upon existing literature by adding a geographic accessibility component. Distance as a factor in consumer-provider contact has often been overlooked in public policy planning (Meade and Earickson 2000). Evaluating geographic

accessibility offers critical information for policy planning and service provision (Apparicio et al. 2008).

Access and Utilization Defined

Access to health care is a broad and multidimensional concept, not easily understood by health researchers. The term *utilization* is also misunderstood. These terms have often been used interchangeably in health care literature. Gaining entry into a healthcare system is a conventional model for access which includes both availability of services and utilizing those services (Gulliford, 2009). Access can be thought of simplistically as the point where a person needing services (the consumer) links or interacts with a person providing the health service that is needed (the provider). However, a complex set of characteristics governs this relationship.

Pechansky & Thomas (1981) argued for a broader concept of access that could be measured as factors along dimensions. Pechansky and Thomas advanced their taxonomy of definitions for which operational measures might be developed regarding the 'degree of fit' between patients and health services across five dimensions (Figure 1).

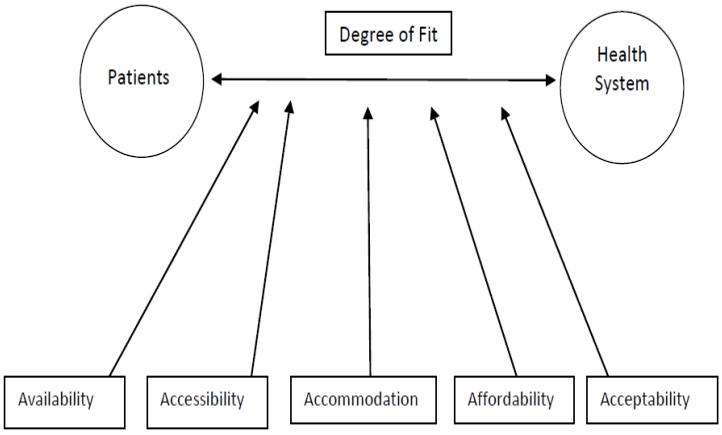

Figure 1: Conceptual Framework for Accessing Health Services

Pechansky & Thomas' five dimensions are: *Availability, Accessibility, Accommodation, Affordability,* and *Acceptability.* The 'degree of fit' acknowledges that after an individual recognizes one needs services, and they are available, there is consent to the role of using the service. There may be differing levels of the degree of fit, and any level of barriers may result in individuals delaying or foregoing health care encounters (McCarthy, Valenstein, Zivin, Zeber, & Kilbourne, 2010). Families and caregivers often need to make trade-offs between these dimensions of access (Exworthy & Peckham, 2006).

The accessibility dimension examines the relationship between the location of providers and the location of patients, taking into account transportation resources, travel time, distance and travel cost. This dimension recognizes that services may be available, but not accessible by subsets of the population. This aspect of the Pechansky and Thomas model holds attraction for those examining geographic concepts in that it proposes specific measures tied to spatial distributions (Ricketts, et al., 1994). The Joint Commission on Accreditation of Healthcare Organizations describes accessibility as a performance dimension which addresses "the degree to which an individual or a defined population can approach, enter, and make use of needed health services" (Joint Commission on Accreditation of Healthcare Organizations, 1998, p.2). Accessibility is a dominant barrier to utilization of health care for rural underserved populations and is geographic in nature (Ricketts, et al., 1994).

The relationship between the location of providers and location of patients falls into the *accessibility* dimension of Pechansky & Thomas' conceptual framework. Distance to the provider serves as an additional impediment to those living in sparsely populated counties. Since the Missouri deregulatory public policies and the public and philanthropic investments to expand clinics being studied were intended to increase market entry and allow children greater

accessibility through increasing the availability of community-based locations, the analysis looks at whether the changes in availability of care for the rural population has had an effect on the accessibility to dental care as measured through distance traveled. Combining measures of travel distance (accessibility) and market supply (availability) are crucial to understanding spatial accessibility (Guagliardo, 2004).

METHODS

The study used Missouri Medicaid/CHIP administrative claims data from 2004 to 2007 for rural children 18 years of age and younger (N=193,165) enrolled at least one month and have at least one dental visit. Dental visit is defined in this study as *any* service with a dental provider. This was intentional as utilizing any dental service with Medicaid/CHIP insurance is wrought with barriers to care in Missouri. The database was purchased from Missouri's claims-processing vendor using external funding from the Deaconess Foundation and the Saint Louis University Department of Public Policy Studies. The file contains all Medicaid/CHIP claims reimbursed for oral health care in the calendar years 2004-2007. The state vendor de-identified all records to protect patient confidentiality prior to shipping. The dataset was analyzed using the PASW/SPSS 18.0 statistical software package. Table 1 shows dental utilization compared with Medicaid/CHIP enrollment for the total population.

TABLE 1: Annual data on Enrollment and Dental Service Utilization, Children aged 3-18, Missouri Medicaid/CHIP

	2004	2005	2006	2007
Number Children Enrolled in Medicaid/SCHIP	533,690[a]	524,773[a]	471,913[a]	472,387[a]
Total Children Utilizing Any Dental Service	142,426	147,453	155,086	152,186
Percent with Any Dental Service	26.7%	28.1%	32.9%	32.3%

[a] Kids Count Data Center

While many have sought to define 'rural' for research purposes, there is no universally accepted definition (Ricketts et al. 1994). From an economic perspective, the counties that remain in the fee-for-service region in Missouri are designated as such by the state Medicaid agency because managed care models of service delivery do not find those counties as marketable ventures for their operations due to the lack of providers and lack of volume encounters. Low population densities in these regions result in low patient volumes and diseconomies of scale (Heady 2002). The managed care designated counties contain a large enough volume to maintain HMO interest in the market. Thus, those children residing in counties in the fee-for-service dataset are more rural in degree than those in the managed care dataset as defined by economic market. Thus, this study used 78 fee-for-service counties in Missouri where children resided. While it is recognized that some counties defined as rural under this definition house larger populated cities (Springfield, Joplin, Rolla, Cape Girardeau), there is an assumption that culturally, psychologically, and economically they understand themselves to be a part of the rural environment. Service delivery systems don't provide services based on population densities, but on serving the larger rural environment.

Travel distance was investigated given two variables in the Medicaid/CHIP dataset: the child's county of residence and location of dental provider at the time of the dental visit. While

dental providers may practice at multiple locations, each provider location and site of service was verified using a combination of the state Medicaid/CHIP address database, the use of internet searches of the practice name, assigning providers to health center practice locations, and personal communications. The exact address of the child was not available due to Health Insurance Portability and Accountability Act of 1996 (HIPAA) privacy rule restrictions. However, the U.S. Census Bureau calculates the population centroid for each county in Missouri (U.S. Census Bureau 2002) [Figure 2] and is a common method used if an exact address is not obtainable. Each child was assigned a county population centroid based on county of residence included in the dataset.

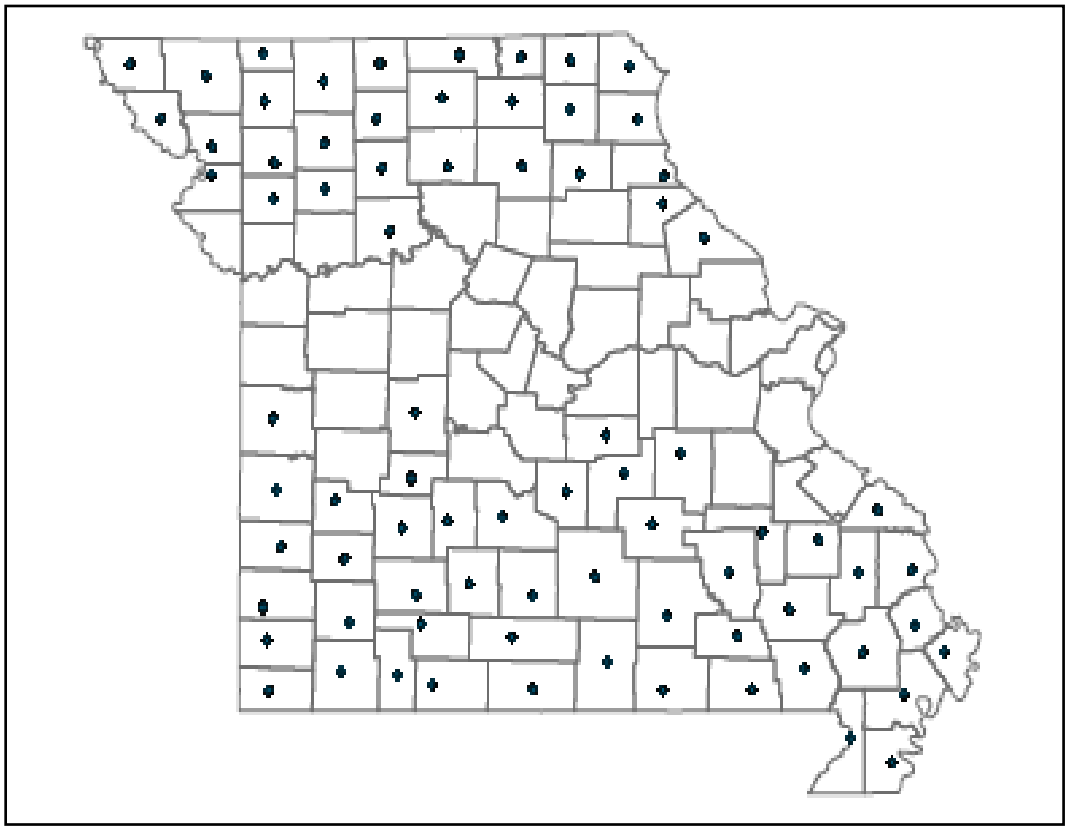

Figure 2: U.S. Census Population Centroids for Missouri Fee-for-Service Counties (2002 U.S. Bureau Calculations)

Each address was then geocoded using an address-to-geocode Internet application conversion website and inserted into the database (LivePhysics.com 2006). Using ArcGIS 9 (Environmental Systems Research Institute, Redlands, CA), the address location of each child and dental provider was mapped onto a state of Missouri shapefile, obtained from the U.S. Census Bureau's 2009 Topically Integrated Geographic Encoding and Referencing (TIGER/Line) shapefiles.

Distance was calculated using shortest network distance – the shortest and fastest path between two points using street networks – to obtain more appropriate results (Apparicio et al. 2008). Physical accessibility may be measured between points of relative location using road distance, which takes into account the actual route taken from a home to a health care provider (Meade and Earickson 2000; Ricketts et al. 1994). Travel distance along a road has been assumed to be an appropriate measure for rural areas given that provider choice is limited (Guagliardo 2004). Using Google Earth 5.2.1, distances to provider locations were obtained after placing the geo-coordinates into the software. Modern applications like Google Earth allow distances to be computed, and it reflects the true experience of rural working families because the software calculates the actual travel distances by determining the Google estimated travel route between the two geocoordinates; in this study, the county centroid and the provider location. Advantages to using software packages like these are that they are effective and user-friendly, street network data is easily accessible, and time required for computing distances is no longer a limitation (Apparicio et al. 2008). All distances computed by the geospatial software for the 193,165 children in the database were placed in the SPSS software/Medicaid database.

The number of dental visits was aggregated by county to determine potential impact on utilization to compare with distances. In order to examine the differences further, the longitudinal data were collapsed into a dichotomous grouping variable. Preliminary market entry

data analysis allowed for the creation of a dataset with two distinct equal pre and post-test periods. Thus, the 2004 and 2005 year data were collapsed into a “pretest” period, and the 2006 and 2007 data were collapsed into a “posttest” period. Creating pre-test and post-test periods constructed a comparison group that proxies for improved accessibility to oral health care clinic providers. This resulted in 95,738 children in the 2004-2005 period, and 97,427 in the 2006-2007 period, totaling 193,165 children in the sample. T-tests were run to examine mean distance differences within counties and test if there were significant changes in distance travelled for the children in those counties. Effects on counties where clinics had been established or expanded in the time period became a second point of focus for the analysis, as well as effects on neighboring counties.

The map (Figure 3) shows the locations where children accessed oral health services in any of the four years included in the study.

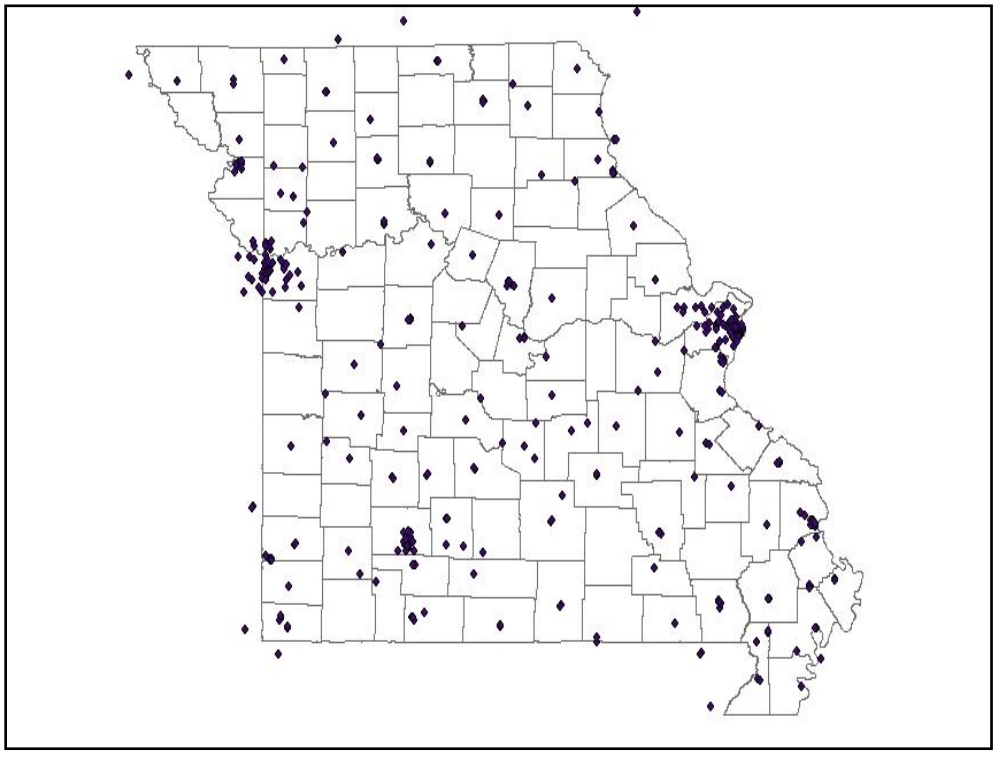

Figure 3: Dental Provider Locations, 2004-2007

Figure 3 visually confirmed the metropolitan locations and potential long distances children were travelling. While no children in the sample reside in the counties along the "central corridor" of Missouri (counties adjacent to Interstate 70 between St. Louis and Kansas City), Figure 3 demonstrates that many children access services in the central corridor, especially in the urban centers of Kansas City, Columbia and St. Louis. A colleague employed at the National Geospatial-Intelligence Agency (NGA) in St. Louis, Missouri recommended partitioning the state into quadrants as a common practice in geospatial analysis. Thus, it was assumed that children and families in rural counties in one quadrant were travelling to the major metropolitan markets in the central corridor closest to that quadrant (for example, families in northwest Gentry county may be travelling to Kansas City to obtain services).

FINDINGS

One single Missouri County map was produced to field test spatial distances travelled. Figure 4 maps the provider locations utilized by children in Clark County, Missouri. Clark County is the northernmost eastern county in Missouri (shown in red). The dots on the map show the locations of dental providers accessed between 2004 and 2007 by children living in the county.

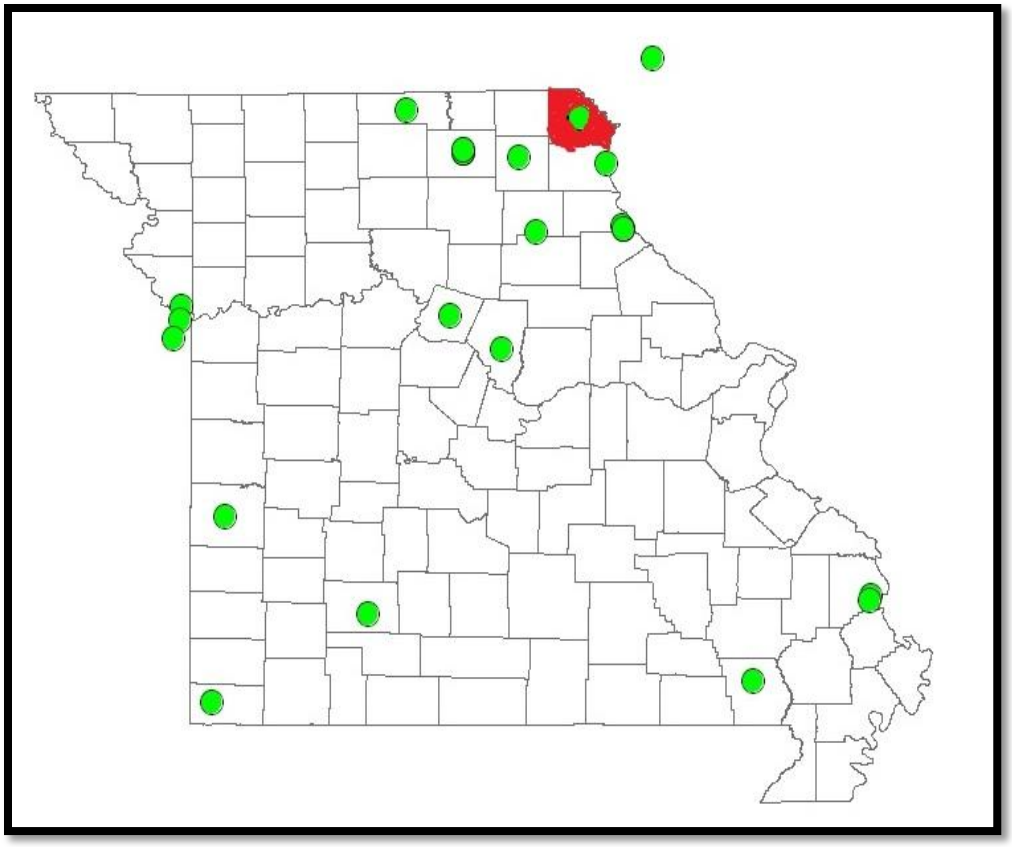

Figure 4: Clark County, MO (in red) and Dental Visit Provider Locations for Medicaid/CHIP Children, 2004-2007

As suspected, families were travelling across multiple counties within the northeast sector of the state, into the central corridor of Missouri, into the far reaches of other parts of the state, and even out of state (Iowa and Kansas shown on map). In addition, mean distances were plotted to scrutinize whether large distances were being travelled to obtain care. Examination of box plots (not shown) on the distance measure showed a heavy volume of families travelling between 100 and 300 miles (one-way) or more to obtain dental services. Although studies have investigated patient choices delineated by the organization of health care and its impact of patient willingness-to-travel (Exworthy and Peckham 2006), Figure 4 shows something unique to Medicaid/CHIP. Given limited choices of providers who accept Medicaid/CHIP insurance coverage, family caregivers in rural regions may travel great distances to obtain any necessary

care for their child. More distant providers may be the only acceptable choice given limited local choices (Exworthy and Peckham 2006).

The distance travelled to provider was used as a continuous dependent variable in analysis comparing distances travelled based on the type of providers used by families. T-tests were run to examine mean distance differences within counties and test if there were significant changes for the children in those counties. Figure 3 suggested that rural families travelled to particular metropolitan areas to obtain dental care; for example, families from northwest Missouri would travel to Kansas City or St. Joseph for their oral health needs; families from the Bootheel would drive to St. Louis or Springfield for services; and families in the Hannibal and northeast regions would drive down to St. Louis. A University of Missouri-Kansas City dental expert and clinic administrator verified this field-based interpretation. By using quadrants, the concept or rurality is expanded to acknowledge that there is a continuum of landscapes in a rural environment. The results on all 78 counties are in Tables 2-5, categorized by their quadrant.

Table 2: County Mean Distance Changes 2004-2005 to 2006-2007
Northwest Quadrant (NW)

County	Year	Dental Visits	Mean Distances	Amount and Direction of Change
Clinton	2004-2005 2006-2007	255 270	46.0 36.4	- 9.6
Atchison	2004-2005 2006-2007	400 271	26.2 20.2	- 6.0
Holt	2004-2005 2006-2007	247 241	33.9 28.7	- 5.2
Andrew	2004-2005 2006-2007	502 490	12.3 9.5	- 2.8
Harrison	2004-2005 2006-2007	387 341	26.9 24.6	- 2.3
Worth	2004-2005 2006-2007	174 125	17.8 17.6	- 0.2
Carroll	2004-2005 2006-2007	541 502	21.0 21.0	0.0
Daviess	2004-2005 2006-2007	560 415	12.7 13.4	+ 0.7
Livingston	2004-2005 2006-2007	615 594	9.7 10.6	+ 0.9
Buchanan	2004-2005 2006-2007	4262 3900	6.1 7.9	+ 1.8
Nodaway	2004-2005 2006-2007	486 450	11.0 13.5	+ 2.5
Dekalb	2004-2005 2006-2007	284 220	29.2 32.3	+ 3.1
Mercer	2004-2005 2006-2007	129 101	42.8 46.0	+ 3.2
Caldwell	2004-2005 2006-2007	405 284	27.7 31.0	+ 3.3
Gentry	2004-2005 2006-2007	258 195	34.4 39.6	+ 5.2
Grundy	2004-2005 2006-2007	487 424	19.0 25.9	+ 6.9
Total	**2004-2005** **2006-2007**	**9992** **8823**	**14.9** **15.4**	**+ 0.5**

Table 3: County Mean Distance Changes 2004-2005 to 2006-2007
Northeast Quadrant (NE)

County	Year	Dental Visits	Mean Distances	Amount and Direction of Change
Clark	2004-2005 2006-2007	327 433	139.5 20.6	- 118.9
Linn	2004-2005 2006-2007	588 527	41.0 37.2	- 3.8
Scotland	2004-2005 2006-2007	174 165	59.3 55.6	- 3.7
Shelby	2004-2005 2006-2007	342 296	45.0 45.0	0.0
Knox	2004-2005 2006-2007	247 212	34.7 34.8	+ 0.1
Ralls	2004-2005 2006-2007	366 313	18.1 19.0	+ 0.9
Macon	2004-2005 2006-2007	481 525	56.0 57.2	+ 1.2
Pike	2004-2005 2006-2007	647 580	35.8 38.0	+ 2.2
Marion	2004-2005 2006-2007	1609 1557	11.2 13.7	+ 2.5
Lewis	2004-2005 2006-2007	343 281	49.1 52.8	+ 3.7
Sullivan	2004-2005 2006-2007	230 227	48.8 54.3	+ 5.5
Schuyler	2004-2005 2006-2007	228 214	37.1 46.3	+ 9.2
Adair	2004-2005 2006-2007	947 978	20.1 30.0	+ 9.9
Putnam	2004-2005 2006-2007	203 168	30.3 40.2	+ 9.9
Total	**2004-2005** **2006-2007**	**6732** **6476**	**35.7** **32.6**	**- 3.1**

Table 4: County Mean Distance Changes 2004-2005 to 2006-2007
Southwest Quadrant (SW)

County	Year	Dental Visits	Mean Distances	Amount and Direction of Change
McDonald	2004-2005 2006-2007	1675 1814	38.6 17.0	- 21.6
Taney	2004-2005 2006-2007	1970 2565	51.1 33.4	- 17.7
Newton	2004-2005 2006-2007	2299 2686	31.3 21.0	- 10.3
Christian	2004-2005 2006-2007	2046 3027	24.2 17.6	- 6.6
Barton	2004-2005 2006-2007	518 664	58.6 53.2	- 5.4
Stone	2004-2005 2006-2007	1092 1516	46.2 42.5	- 3.7
Dade	2004-2005 2006-2007	435 521	45.3 41.7	- 3.6
Jasper	2004-2005 2006-2007	5550 6241	21.6 18.9	- 2.7
Wright	2004-2005 2006-2007	1328 1428	59.9 58.8	- 1.1
Barry	2004-2005 2006-2007	1278 1639	55.5 54.6	- 0.9
Lawrence	2004-2005 2006-2007	1742 1872	27.6 27.5	- 0.1
Greene	2004-2005 2006-2007	9581 10675	12.4 12.4	0.0
Webster	2004-2005 2006-2007	1493 1716	32.1 32.9	+ 0.8
Benton	2004-2005 2006-2007	853 820	37.9 38.9	+ 1.0
Dallas	2004-2005 2006-2007	964 1033	33.4 35.4	+ 2.0
Polk	2004-2005 2006-2007	2153 2224	15.5 17.5	+ 2.0
Hickory	2004-2005 2006-2007	676 684	23.9 26.5	+ 2.6
Cedar	2004-2005 2006-2007	741 779	47.6 50.5	+ 2.9
Vernon	2004-2005 2006-2007	869 908	62.3 66.6	+ 4.3
Bates	2004-2005 2006-2007	443 509	59.6 65.8	+ 6.2
Douglas	2004-2005 2006-2007	1023 939	33.8 40.4	+ 6.6
Laclede	2004-2005 2006-2007	2296 2350	32.3 41.9	+ 9.6
Ozark	2004-2005 2006-2007	616 607	31.7 50.7	+ 19
Total	**2004-2005** **2006-2007**	**41,641** **47,217**	**29.5** **27.7**	**- 1.8**

Table 5: County Mean Distance Changes 2004-2005 to 2006-2007
Southeast Quadrant (SE)

County	Year	Dental Visits	Mean Distances	Amount and Direction of Change
Oregon	2004-2005 2006-2007	677 749	75.0 53.3	- 21.7
Howell	2004-2005 2006-2007	2299 2631	57.9 38.7	- 19.2
Madison	2004-2005 2006-2007	552 670	50.0 41.4	- 8.6
Pulaski	2004-2005 2006-2007	1774 1519	34.5 29.5	- 5.0
New Madrid	2004-2005 2006-2007	1753 1597	23.1 18.9	- 4.2
Iron	2004-2005 2006-2007	596 486	62.9 59.6	- 3.3
Carter	2004-2005 2006-2007	643 615	35.1 32.7	- 2.4
Scott	2004-2005 2006-2007	2849 2787	25.2 23.1	- 2.1
Mississippi	2004-2005 2006-2007	1317 1321	23.9 22.0	- 1.9
Butler	2004-2005 2006-2007	3047 2587	13.6 11.9	- 1.7
Bollinger	2004-2005 2006-2007	818 731	30.9 29.3	- 1.6
Cape Girardeau	2004-2005 2006-2007	2686 2558	12.2 11.3	- 0.9
Phelps	2004-2005 2006-2007	2713 2381	17.4 16.8	- 0.6
Crawford	2004-2005 2006-2007	1552 1421	24.5 24.0	- 0.5
Maries	2004-2005 2006-2007	476 424	24.6 24.6	0.0
Ripley	2004-2005 2006-2007	1144 1110	43.8 43.8	0.0
Pemiscot	2004-2005 2006-2007	1899 1579	22.7 23.2	+ 0.5
Shannon	2004-2005 2006-2007	739 634	65.7 66.3	+ 0.6
Stoddard	2004-2005 2006-2007	1831 1885	27.3 28.4	+ 1.1
Perry	2004-2005 2006-2007	693 611	7.6 8.9	+ 1.3
Wayne	2004-2005 2006-2007	1008 916	59.1 61.1	+ 2.0

Table 5 cont.

County	Year	Dental Visits	Mean Distances	Amount and Direction of Change
Dent	2004-2005 2006-2007	1367 1219	19.5 23.2	+ 3.7
Reynolds	2004-2005 2006-2007	597 594	39.9 44.7	+ 4.8
Dunklin	2004-2005 2006-2007	2671 2293	35.9 43.2	+ 7.3
Texas	2004-2005 2006-2007	1672 1593	39.0 51.7	+ 12.7
Total	**2004-2005** **2006-2007**	**37,373** **34,911**	**30.5** **29.6**	**- 0.9**

The overall mean travel distance on all child visits by quadrants are shown in Table 6 and plotted in Figure 5 for the pre and posttest periods. The travel distances represent one-way values in miles. Of the total sample (N=193,165), the mean one-way travel distance for the 2004-2005 period (pretest) was 28.8 miles, and the mean distance for the 2006-2007 period was 27.5 miles ($p<.001$). Clark County, featured in Figure 4, and listed in Table 3, showed a 119 mile decrease between the pre and post periods, the largest decrease for a county. However, because the travel distance variable could not be compared with other variables for statistical testing, only assumptive interpretations can be offered: children in the post-test period may have had access to a new clinic in the northeast quadrant that was not previously available and therefore, did not have to travel as far; it may be because children in the post-test period had less severe problems (needing oral surgery or orthodontic care, for example) and did not have to travel as far to access dental specialists.

Table 6: Quadrant Mean Distances

Quadrant	Time Period	N	Mean Distance (miles)	Direction of Change	p
NW	2004-2005	9992	14.9		
	2006-2007	8823	15.4	increase	p=.193
NE	2004-2005	6732	35.7		
	2006-2007	6476	32.6	decrease	p<.001
SW	2004-2005	41,641	29.5		
	2006-2007	47,217	27.7	decrease	p<.001
SE	2004-2005	37,373	30.5		
	2006-2007	34,911	29.6	decrease	p<.001
Total	2004-2005	95,738	28.8		
	2006-2007	97,427	27.5	decrease	p<.001

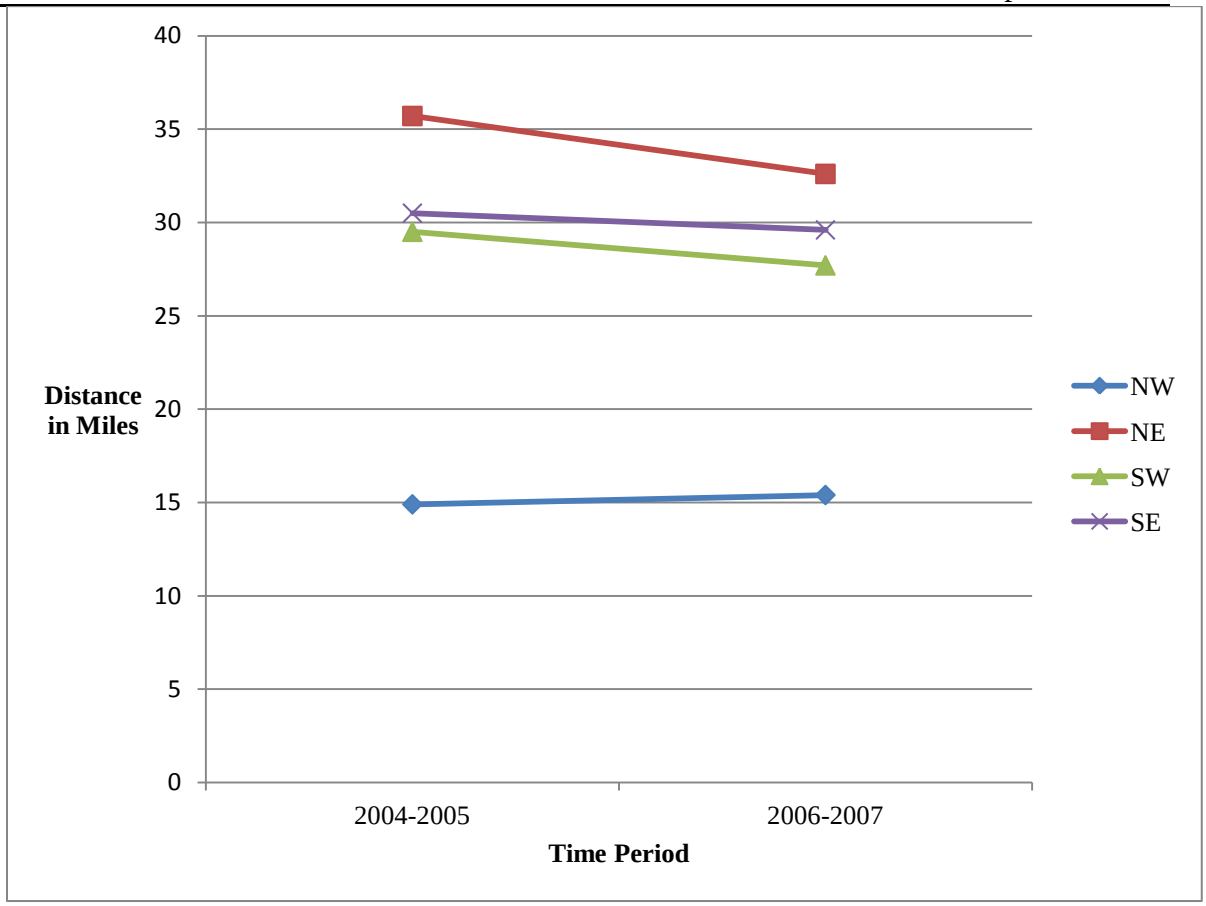

Figure 5: Plot of Mean Distance Changes between Pre and Posttest Periods

The data demonstrate there were total decreases in mean distances for three of four quadrants. Only the Northwest quadrant showed a slight increase in mean distances traveled by families. With individual counties, (Tables 2-5), 40 counties showed increases, 32 showed decreases, and 6 showed no change. A higher percentage of decreases were in the Southern-tier counties. However, because the sample is so geographically disparate, the results should be interpreted with caution. It was better to unmask the differences by examining the county level differences within the quadrants as it pertained to clinic locations.

Of the total sample (N=193,165), the mean one-way travel distance for the 2004-2005 period (pretest) was 28.8 miles, and the mean distance for the 2006-2007 period was 27.5 miles. First, an average distance of close to 30 miles one-way is a large distance for families to travel for dental care and may be an impact on Missouri's low percentage of children with a dental visit (typically around one-third of the Medicaid/CHIP population). Second, a decrease of 1.3 miles may not appear to be a meaningful reduction with such a large sample size. Thus, a second focus of this analysis examined if there were impacts on children residing within or near the counties that had expanded clinics due to the policy changes.

Table 7 shows the mean one-way distances travelled for children residing in a county specifically where new clinic locations were established and a new source of dental service may have been selected by the family, thereby decreasing the length of travel to access care. Eight of eleven counties showed decreases in distance travelled. The two that showed increases were along the northern tier of the state.

Table 7: Counties with Establishment of New or Expanded Clinics in Post-test Period (2006-2007)

County	Year	Dental Visits	Enrollment Medicaid/CHIP* 2004, 2007	Mean Distances (miles)	Amount and Direction of Change
McDonald	2004-2005	1675	3540	38.6	- 21.6
	2006-2007	1814	3054	17.0	
Howell	2004-2005	2299	5340	57.8	- 19.0
	2006-2007	2631	4555	38.8	
Taney	2004-2005	1970	4826	51.1	- 17.7
	2006-2007	2565	4440	33.4	
Christian	2004-2005	2046	5253	24.2	- 6.4
	2006-2007	3027	5083	17.8	
New Madrid	2004-2005	1753	3062	23.1	- 4.2
	2006-2007	1597	2546	18.9	
Andrew	2004-2005	502	937	12.3	- 2.5
	2006-2007	490	738	9.8	
Butler	2004-2005	3047	5417	13.6	- 1.9
	2006-2007	2587	5139	11.7	
Phelps	2004-2005	2713	4272	17.4	- 0.8
	2006-2007	2381	3555	16.6	
Webster	2004-2005	1493	3481	32.5	+ 0.3
	2006-2007	1716	2938	32.8	
Buchanan	2004-2005	4262	8352	6.1	+ 1.8
	2006-2007	3900	8091	7.9	
Adair	2004-2005	947	1916	20.1	+ 10.2
	2006-2007	978	1700	30.3	

* Source of Enrollment Data: Kids Count Data Center, Annie Casey Foundation

Of further significance in Table 7 is that Christian, Howell, McDonald and Taney counties showed significant drops in distance travelled *combined* with significant increases in utilization (number of dental visits). The fourth column in Table 7 shows the enrollment in Medicaid/CHIP in 2004 and 2007 for the counties as well. Enrollment in Medicaid/CHIP

decreased for all 11 counties in the period studied. Thus, increases in dental visits are less likely to be a result of increased enrollment in public coverage. The data in Table 7 may be showing the positive effect on distance the clinics are having for children residing *within* a county with new or expanded services.

Effect on Children Residing in Neighboring Counties

While Table 7 reports changes for children residing *within* the county in which new or expanded clinics were established, it was suspected that the clinics may have had the effect of increasing access for children in adjacent or nearby counties. Table 8 reports counties where service hubs have significantly impacted both utilization and distance travelled for families.

Table 8: Examination of Service Hub Locations and Impact on Neighboring Counties between the 2004-2005 and 2006-2007 Periods.

County	Mean Distance Decrease	Increase in Dental Visits	Hub location (where nearby county clinic is located)
Clark	118.9 miles	106	NEMO Kirksville (Adair County)
Madison	9 miles	108	St. Francois County Clinic (St. Francois County)
Newton	10.3 miles	387	ACCESS and ACHE (McDonald County)
Oregon	21.7 miles	72	Southern Mo CHC (Howell County)
Stone	3.7 miles	424	Children's Smile Center (Christian County)

The data may be showing the positive impact the clinics have had in increasing utilization and decreasing miles travelled for children residing in neighboring counties, thus demonstrating a

potential "service hub" effect of the clinics. Children in Oregon county, adjacent to Howell county, were frequenting the clinic more often in the post-test period and travelling a shorter distance by an average of 21 miles one-way. While the four other counties directly adjacent to Howell did not show the same effects, it may due to lags in outreach or other factors given there were only two years of data in the post-test period. Madison county is a fee-for-service county in the study, while neighboring St. Francois county established a clinic having impact on Madison although officially in a managed care region (thus St. Francois is mentioned in Table 8 but not in Table 7).

DISCUSSION AND CONCLUSIONS

The data indicate families residing in rural counties are travelling on average close to 30 miles to obtain appropriate levels of care for children. However, it was discovered that the overall travel distances for rural families in some counties were decreasing, and may be attributable to the expansion of public health clinic locations. Clinics were found to have "hub" properties, improving the geographic availability of care to children in rural counties that may have otherwise had to travel long distances. The results indicate that Missouri public policies supporting expansion of the workforce supply, and both public and private investments in community-based clinics may be having similar transforming effects as deregulation of the transport and airline industries. Industry deregulation provides natural experiments to allow observations of natural selection in organizational form (Kole and Lehn 1997). After the Airline Deregulation Act of 1978, airlines redesigned route structures as "hub and spoke" systems (Kole and Lehn 1997). The establishment of hubs through clinics may allow cost savings for families through reduced travel time and cost, and provides volume for clinics. Hubs are geographically accessible and confer benefits on specific regional areas that they serve (O'Kelly 1998). The

creation of dental service hubs are having a significant effect on decreasing distance travelled and increasing dental visits for children in counties neighboring counties with hub service locations.

According to Rueben Warren, former Associate Director for Minority Health at the CDC, oral health care professionals should shift their focus away from curing oral diseases to guaranteeing the total well-being of an individual in order to successfully address the health care needs of underserved communities, including having an effect on the public policy arena (Warren 1999). Policymakers should take an intentional strategy of *service hubs* in public policy. This may not be without political controversy. Daneman (2009) reported that the Missouri Dental Association's rural members expressed concern over the growing economic impact on private practices of expanding oral health services at community health centers. While a limitation of the study may be that the results are not generalizable to states other than Missouri, the method and the data analysis could be helpful for studies in other states, especially those that have similar characteristics to Missouri – low reimbursement rates to dentists, support for community-based clinics, and unsupervised practice of hygienists in public health settings.

However, the findings of this research indicate continuing deregulation and investment in community-based clinics may positively contribute to the development of hub-and-spoke networks. This was an empirical phenomenon from the data, as there wasn't any prior stated intention in the policy changes to create hub-and-spoke networks. Dental hygienists and other health professionals can serve as preventive care service spokes doing outreach in public health settings and community based sites, while also being a referral service for more intensive care at the hubs. A strategy to increase the available supply of professionals in the workforce includes expanding the current roles of professionals within the dental profession (Niessen 2006). One

example is the Alaskan Native Health Care delivery system which is intentionally organized by a hub-and-spoke pattern of regional care (Sherry 2004). Allowing greater market entry through deregulation could provide states with greater improvements to their public dental health infrastructure. There is growing consensus that a multi-pronged, multi-disciplinary, comprehensive approach will achieve the greatest outcomes. An appropriate role for private dentists in an integrated delivery system may be as tertiary providers, allowing others (hygienists, etc) to serve as managers of primary prevention (Garcia et al. 2010). Given the fiscal constraints of state budgets, the most efficient way to serve the population may be to continue broadening the scope of dental public health to allow for greater market entry.

One limitation of this study is that aggregation error occurs from the distribution around the county centroid in not having the exact address of the child (Apparicio et al. 2008). However, using the population centroid minimizes the error and evenly distributes it across the population. Further research should entail obtaining exact child addresses linked to the de-identified Medicaid DCN number. A second limitation of the study is in selecting any dental service as a dental visit. Oral surgery and orthodontia in particular serve as outliers for longer travel distances as these services are extremely limited to the Medicaid/CHIP population. Those travelling the largest distances typically sought intensive services, such as dental surgeries, pediatric specialty care, or orthodontia, however those travelling over 150 miles only accounted for 1.3% of the sample. For further research, addition of the 2008 to 2011 datasets would greatly enhance the ability to track the utilization and travel patterns over time, and the potential confounder of the high needs orthodontia and oral surgery data could be treated separately.

Because Missouri hygienists can submit claims under the name of the dentist, health center, or their own name, it is uncertain how many are practicing under this act. In addition,

policies and investments have lag effects, so we are not able to attribute observed changes directly to the policies, especially in consideration of other confounding factors. To strengthen this study, we could construct a comparison group of children in counties between those with verified changes in availability of care and those without changes to compare mean distances.

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